Virgil Robot at Racconigi's Castle: a Design Challenge

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Abstract. This paper discusses the role of Design Research (DR) as a mediator between robotics and cultural heritage. This issue has been addressed in the project Virgil, a telepresence robot for visiting inaccessible areas of Racconigi Castle in Piedmont, Italy. A project developed applying an iterative design process that combines the traditional activities of design practice, such as product and service design, to a more theoretical and conceptual activities of DR aimed to generate a meaningful solution. Both the museum context and the state of the art of museum robotic applications have been analysed to define the ethical requirements for the development of the service. The analytical phase is followed by the design stage in which a service concept has been defined, through a process of continuous debate and co-design with various stakeholders. The process has led to the prototyping of a dedicated robot tested in the real environment with random visitors.

Keywords: Cultural Heritage Service Design, Human-Centred Design, Museum Cultural Experience, Robotics, Reboethics, Robot Acceptability

1 Introduction

In the last few decades we have become accustomed to the use of robots supporting many human activities, such as in factories and explorations, but recently we are witnessing the spread of robots even in everyday life activities. As a result, this phenomenon is leading to deal with crucial factors such as: effective usefulness [1] and social acceptability [2]. Roboticists, indeed, are now asked to answer questions like: *is this application actually creating value? Will people recognize the function of this robotic application? Compared to existent solutions, is this application worthwhile? Is this solution appropriate and respectful of the context? How the introduction of this solution will affect people?*

These questions highlight how the issue of moving new technologies from the laboratories to the real world involves a very complex process in which the hypothesis of the use is just the beginning. This issue is even more relevant in some specific contexts, such as Cultural Heritage where the human-robot coexistence [2] introduces social problems affecting not only the direct human-robot interaction (HRI), but rather, the roles assumed by robots in society that can change and redefine the human social standing [2]. For this reason, it is becoming increasingly relevant a transition from a technology driven approach, in which the design process start thinking about the opportunities offered by technologies, to a value-centred approach [3], based on social and cultural understanding and aimed to meaningful solutions. These considerations are at the basis of the project Virgil, a teleoperated robot for the exploration of inaccessible areas of the Racconigi Castle.

Developing meaningful robotic solutions represents both a challenge and a great opportunity for Design Research (DR), which is currently redefining its role in the word of robotics. From a first approach, mainly related to the traditional activities of the design practice, such as the design of shells or interfaces, design is now establishing itself as a mediator between the technology and the cultural ecologies [3] in which it has to be introduced.

2 Related work

In order to understand which role Design Research could have played in robotics projects we started with a literature review, including the work of both Design researchers and roboticists. First of all, we noticed that there is a general agreement about the main aim of DR: production of knowledge. Archer [4], indeed, defined DR as the "*systematic inquiry whose goal is knowledge of, or in, the embodiment of configuration, composition, structure, purpose, value, and meaning in man-made things and systems*". This has been reiterated by Zimmerman et al. [5] whose contribution is fundamental for the creation of a common understanding among HRI researchers. It refers to DR as the "*intention to produce knowledge and not the work to more immediately inform the development of a commercial product*" [5]. Even if his work refers to human-computer interaction (HCI), it is also valid for HRI since in both cases DR faces analogous issues with similar stakeholders.

Nevertheless, it has been stressed that DR is not a mere process of collection of knowledge, but rather an interpretive activity that lead to the development of scenarios of meaning and, subsequently, meaningful applications of human-robot interaction. To be more accurate, the production of knowledge is not just preliminary to the production of applications and artefacts but it is also a consequence of that. In this regard, Zimmerman at al. [6] propose a knowledge opportunity map, in which they highlight the opportunities related to the production of knowledge at each stage of a design process, such as the definition of the user's mental models at the discover stage, to the acceptance factors in the reflect stage.

Looking at a specific application context as Robotics, the application of Design Research methodologies can lead to a wide range of different interpretations of the same technologies and it can also drive to overcome the focus on the robot on behalf of the enhancement of the human-human interaction. Fink et al. [7], for instance, designed a robot aimed to motivate children to tidy up their room from toys, which appears as an ordinary object of the domestic environment. In this case, the focus is on the function and the role that this robotic solution assumes in the house. The same also occurs with Kip1 [8], a robot resulting from an investigation process focused on human-human interaction. This robot, which looks like a table lamp, is influenced and influences a conversation between people, through peripheral interaction [8]. In both cases a great importance is given to prototyping and testing, and the appearance of the robots is designed accordingly to the meanings these assume: a “RObject” [7] that supports children in their tidy up activity, and an indirect interlocutor that reacts to human conversations. The two examples, besides, challenge the aesthetic stereotype of robot since the focus is not on the robot but rather on the effect that this would generate.

The knowledge building process operated by DR moves the focus of the projects from technology to people and to the meaning that these assume in the context. For the same reason, other projects focus more on the decision making process (DMP) and on the methods to develop participative solutions. This approach is applied especially in the case of project that requires not only the design of an artefact, rather the design of a service. The work of Sabanovic, for instance, highlights the importance of an iterative process, developed at multiple levels. Since the research usually focuses on technical capabilities and often forget to take into account the social environment it will affect, she suggests that the design process should be approached putting values at the centre of the project, incorporating social and cultural meaning-making [3]. She suggests multiple ways to apply this value-centred design approach, including tests in the real environment instead of labs, systematic study of the potential context of use, iterative process of prototyping and testing and involving social group in the decision making process. Similarly, the work by Verganti [9], which is mainly business oriented, emphasizes that the design process is able to create innovation through the definition of a scenarios of meanings, instead of a single solution, which can take the form of mood board, storyboard or a prototype and is built through continuous debate among the various stakeholders.

Therefore, DR moves the centre of the project from the technology to the meaning and the human experience, and the participatory approach allows it to build social aware solutions with which people can build a sense of familiarity and ownership. These two main concepts were at the basis of the design process that we applied to develop a robotic solution able to enhance the relationship between visitors and museum guides. But we also tried to make a step forward. Most of literature about DR applied to Robotics does not provide examples of projects that face the complexity of public real environment and the social and political implications that ensue. The contribution that our work aims to give is to provide an overview of strategies that can be applied in this regard.

3 Design Process

The project Virgil was developed under the curatorship of our design team, from Politecnico di Torino, composed of three members. Nevertheless, the whole design process involved actively various stakeholders. First of all, the promoters of the project: Jol CRAB (*Connected Robotics Application laB*) and the Terre dei Savoia association, promoter of cultural activities on the territory. They signed a partnership contract also with the “Superintendence”, which gave the approval to use the Racconigi Castle as a context for the experimentation. These represents the stakeholders directly involved in the decision making process (DMP) and the design team has been involved as additional partner in order to investigate the context e lead the design process. The whole project was also developed in collaboration with a representative of the museum guides who attended all the roundtables, the tests and provided deep knowledge about the heritage and, above all, the visitors.

As often happens among designers [6], we approached the project in a highly social approach, giving room for debate and direct confrontation with the consequent risk to not properly capture the knowledge built during the whole process. In order to avoid this and make this experience sharable we attempted to alternate moments of production, debate and synthesis for all the phases of the design process. The *production* stages consist in the specific activities of the design team (such as stakeholders mapping, user journey, storyboarding etc.) that were produced and then elaborated mostly in slide presentations. The slide presentations were then used during the debate stages as a basis for the discussion and the decision making process. The production stages, also, concerned the three main phases of the project development: analysis, design and test. The *debates* were organized in the lab as roundtables involving the various stakeholders and took place about once a month. In total we carried out around 20 roundtables in 18 months, starting from April 2014. Additionally, smaller meetings, focused on specific topics, took place approximately once a week. These meetings did not involve all the stakeholders but only those involved in the specific topic. This continuous involvement of the various stakeholders in the decision making process allows the contamination between the various domains of each [10] which lead to generate more creative ideas, acceptable and valuable for the whole, or at least a large part, of the museum ecology. During each brainstorming session, different topics of the project have been presented, in the form of visual representations of some aspects of the projects, combining pictures and texts, in order to allow an easier communication of the issues. In the *synthesis* phase, all the feedbacks, suggestions and directions for things to do next, as well as a summary of the debates, were collected in reports and to-do lists by the design team and then shared with all the other stakeholders.

4 The Virgil Project

4.1 Context: Racconigi Castle

We built knowledge about the Racconigi Castle, and more generally about Cultural Heritage, combining different actions, such as immersive investigation, literature review, online data collection and the dialogue with various stakeholders. The information revealed by these actions were then organized in a series of scenario boards, a stakeholders-map and written reports.

The *scenario* is defined as a form of story that describes a context in which a device or a product is used together with the ways to use it [11]. This story can be represented as a combination of visual and textual information. A scenario board is an effective tool to provide a general overview of the physical context, the activities that take place there and its social dynamics. This represents a fast and easy way of communicating concepts to various stakeholders [12] enabling the debate about emerging issues and design opportunities.

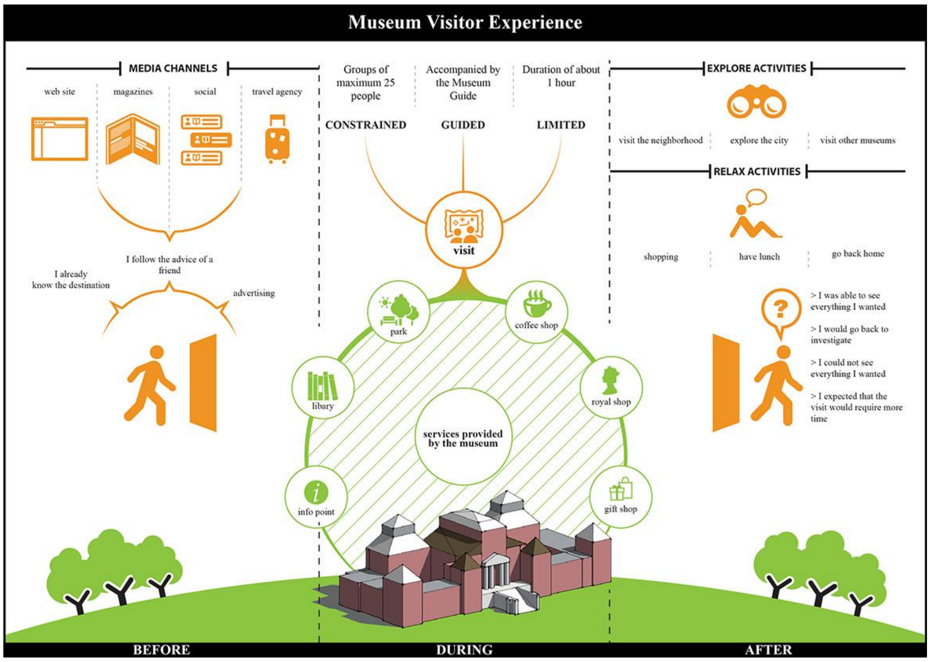

Fig. 1. Overview of the visiting experience at Racconigi Castle.

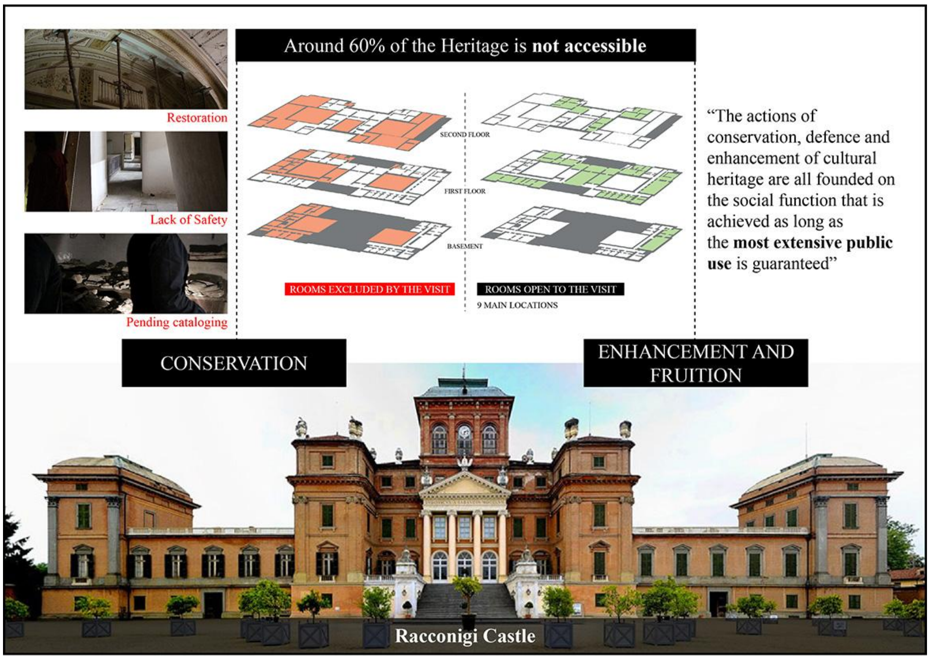

Fig. 2. Racconigi Castle: fruition, conservation and accessibility.

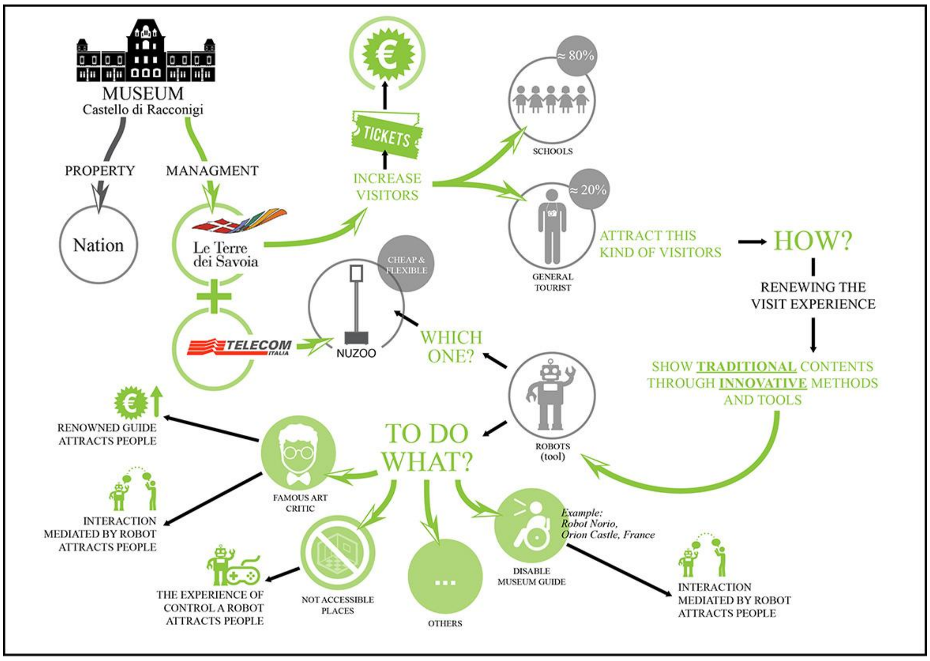

Fig. 3. Museum ecology, stakeholders, desired improvements and rough ideas.

The Racconigi Castle is a Savoy summer residence, in Piedmont, Italy. This so-called *villa of delights* is an UNESCO World Heritage site [15], thanks to its richness in terms of architecture, art works, antique furnishing and objects, all preserved almost unchanged from the time the castle was still inhabited. This residence is, also, very important because of its wide park, well renowned in Garden Art History for the large number of plants and their variety [15]. Despite the richness of this heritage, it was estimated that around the 60% of the castle is not accessible for visitors, mainly because of the state of conservation, fragility or problems of logistic management.

In order to completely understand the [13] of this cultural context it was necessary to analyse the three main aspects that characterize it: *liminality*, *sociality* and *engagement* [13]. From the liminality point of view, the Racconigi Castle offers the chance to “enter” in the real life of the royal family, in a very impressive location in which is possible to see both the royalty and the normality of everyday life. From the sociality point of view, the visit is mandatory organized in groups, and visitors are mainly couples, families, classes or friends, interact with the people with whom they came. Whereas, in this context, the groups are mandatory accompanied by the museum guide, which assumes a central role in the visit ritual. Moreover, the storytelling activity performed by the museum guide together with his ability to interpret the visitors is a key factor for the transference of cultural understanding [16].

The peculiar nature of the visit in the Racconigi Castle was observed directly by the design team in two different sessions.

The first session consisted of an immersive investigation during which we attended a normal guided tour at the castle together with other visitors. During this experience we notice the central role of the storytelling performed by the museum guide and the main aspects of the contents showed, which are: the everyday life, curiosity about historical personalities and material culture. The visit has duration of an hour and the groups consist of about 20 visitors. What we noticed is that in same areas of the castle, such as in same narrow corridors and rooms, it was impossible for the whole group to stand close to the museum guide during the explanations, nevertheless his voice was audible.

The second session consisted of a private guided tour organized for the stakeholders involved in the project. During this visit, the museum guide did not perform a conventional storytelling but rather he focused on how people react to the visit, how they behave and how and why the visit is organized in that specific way. As we already mentioned, the visit is organized in groups of maximum 25 persons accompanied by a museum guide. Each time the storytelling is adapted on the basis of the visitor’s interests. The tour route changes according to the desire to show as many areas as possible, over time, while maintaining a similar duration of the visit.

4.2 Stakeholders

In order to understand the social ecology [3] of the Racconigi Castle it is necessary to map all the stakeholders that affect, or are affected, by the project. This is fundamental for the acceptability of the project. In fact, involving them in the DMP allows building a sense of ownership [17] towards the robotic solution.

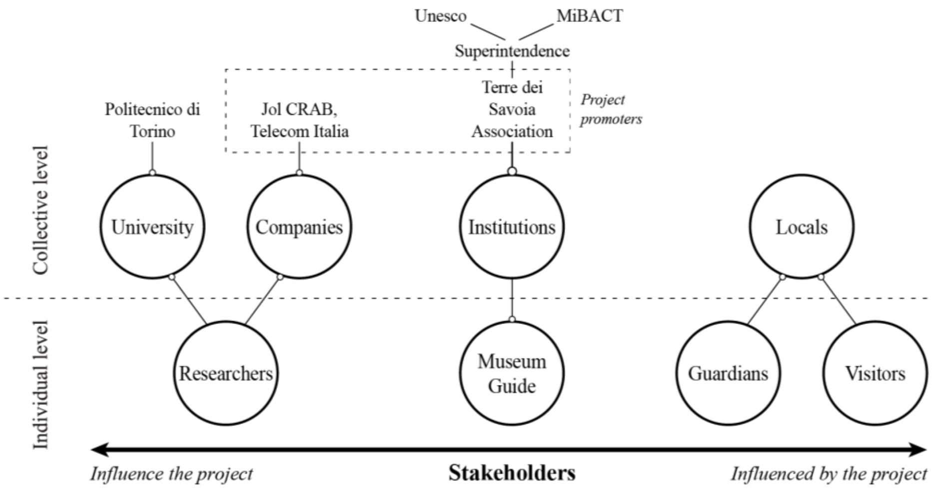

Fig. 4. Stakeholders map of the Racconigi Castle.

In addition to the stakeholders directly involved in the DMP, we found out that there are other stakeholders that may be influenced by the project. First of all, the visitors who represent the direct beneficiaries of the new service, but also the museum guide and the guardians that are entrusted of the accompanying and storytelling activities. At a different level, the project would also affect and be affected by the local community and institutions such as Ministry of Cultural Heritage, companies and Universities that collaborate with the Castle. The act of mapping the stakeholders, which results in graphical visualizations, allows to be aware of the implications and consequences that a project could have [18] and to take into account not just primary actors.

4.3 Robotics Museum Applications: State of the Art

In parallel with the cultural context, the state of the art of robotic applications in cultural heritage has been analysed. From this activity emerged three main category of museum robotics: museum guide robots, telepresence and robotic installations [19]. The first category is very broad and includes examples from all over the world. Already in the nineties took place experimentations with guide robots [20] that were initially addressing problems of navigations and obstacle avoidance [21]. Over time these application faced increasing challenges, such as the dialogue with visitors [22], the ability to express emotions [23], until becoming capable of adapting the guide on the base of people's behaviours and moods [24]. Regarding telepresence robots, whose applications in museums have recently increased, introduce new challenges especially from the service point of view. These are, indeed, used to improve cultural heritage's accessibility for those who are unable to reach the museum site for geographical limitations [25] or for mobility impairments [26]. However, the telepresence allows also to experiencing a visit out of the ordinary, such as exploring a museum during the night, when it is closed for the public [27]. Finally, robotic technologies are increasingly being applied in museum contexts for installations and performances, aiming at the engagement and participation of the visitors [28; 29].

In addition to the analysis of existing museum robotic applications we developed scenario boards from the technological point of view. The engineers provided information about the technology available for the project and the range of possible developments in terms of algorithms. In particular, they provided an overview of mobile robotic platforms, autonomous navigation with related algorithms (such as for obstacle avoidance and mapping) and Cloud Robotics Platform.

4.4 Requirements

From the analysis of the museum ecology and the identification of the stakeholders involved in it emerges two main design goals that the project could meet: increase visibility for the inaccessible areas of the castle and enhancement of the storytelling activity of the museum guides. The project had to fulfil these two emerging needs taking into account the limits and the opportunities offered by the robotic technology. As a matter of fact, we had the chance to use a mobile robotic platform, provided of a camera or a tablet, and able to move teleoperated or autonomously by exploiting the Cloud Robotics Platform.

4.5 Service Concept

The service concept elaborated through this process, based on a continuous debate, is the result of a mutual shaping between robotic opportunities, offered by the lab, and the heritage requirements, emerged by the castle analysis. The proposed service, indeed, consist of an extension of the visiting experience through the use of a telepresence robot located in an inaccessible area of the castle. Furthermore, this robot proposes a use of the robot as a tool for the museum guide.

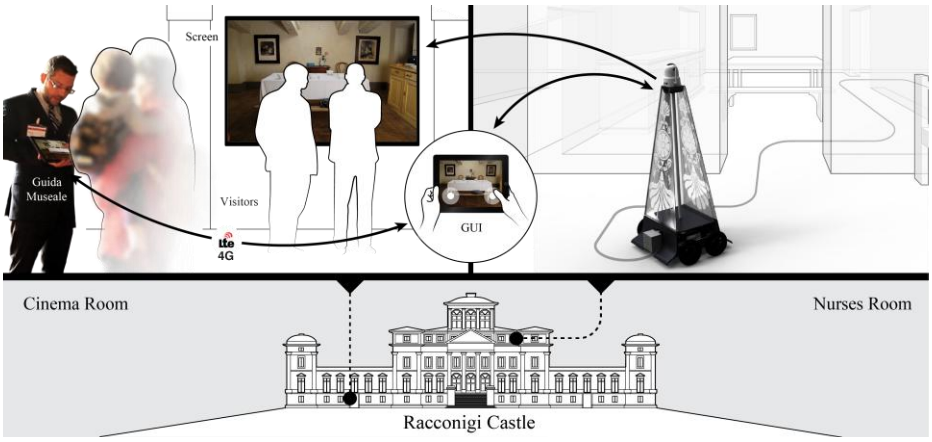

Fig. 5. Virgil service concept.

Once the service concept was defined, in order to show how the visitors would experience the proposed solution, it was necessary to illustrate it. The most effective way to do that is a storyboard [30]. In figure 4, the storyboard shows the main stages of the visiting experience with the introduction of Virgil. The visitors meet the museum guide in front of the castle and then enter to the first room: the hall of Hercules. Then the visit continues through corridors and halls, that are already part of the tour, and then the museum guide shows that some areas are not accessible for visitors. Then the group is accompanied by the guide to the "cinema" room where is located a big projection screen on which he shows the real time video streaming sent by the robot, which is located in the inaccessible area.

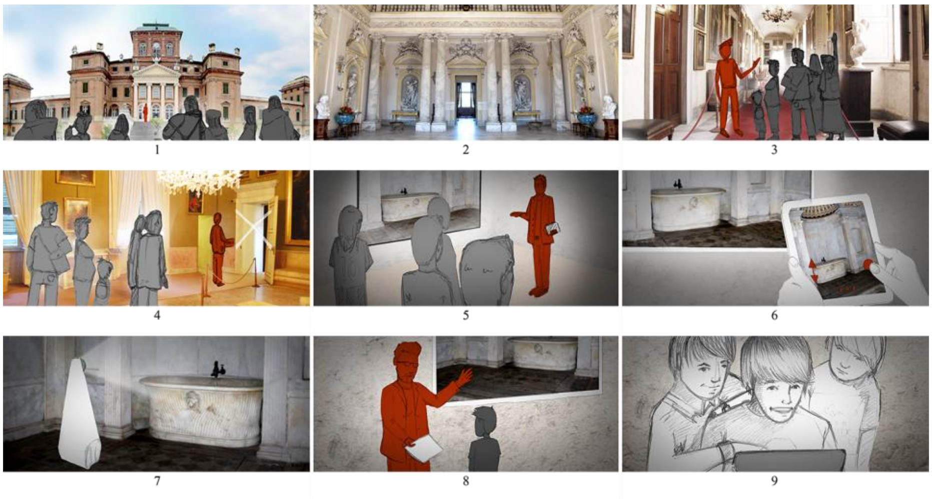

Fig. 6. Storyboard of the new robotic museum experience.

4.6 Robot

The robot consists of a mobile robotics platform that supports a camera at 120 cm from the ground. The hardware has been integrated in a truncated pyramid body, which reminds to an analogous shape diffused in the architecture of Savoy tradition. The robot Virgil, indeed, has been designed considering the artistic elements and material culture of the context for which it was developed. The body of the robot is made of PMMA (poly-methyl-methacrylate), a transparent material, chosen for its lightness, both from the physical and the visual point of view. Furthermore, the front and rear surfaces are provided with an adhesive décor representing a Palagian Palm, a typical element of the Racconigi Castle, applied to furniture and architectural elements. This customization is a consequence of the awareness about the fact that the creation of meaning cannot disregard from the context for which the artefact is designed [9]. Moreover, both the formal synthesis ad the choice of the material result from a process of participative design, in which, the main stakeholders, were involved in two roundtables to discuss these aspects. These discussions aimed to prevent designing solutions unaware of the possible consequences that the introduction of a technological innovation could have on the museum ecology [3]. In the first roundtable we suggested three possible approaches to define the appearance of the robot: minimal-tech, ethereal, dressed up. As minimal-tech approach was meant a synthetic forms combined with some technical elements of are exposed to communicate the function and the nature of the robot. The ethereal approach referred to a totemic element characterized by an extremely synthetic shape that hides the technological and mechanical aspects. Whereas, the dressed up approach consists of covering the robot with a sort of puppet inspired by period costumes of the context. These three typologies were meant to provoke the participants, whom have highlighted two important aspects: the *minimal-tech approach is able to communicate the nature of the robot (from the functional point of view)*, nevertheless, it is interesting to give it a *customization based on the culture of the context*. Subsequently, these two aspects were identified as guidelines for the design of the robot.

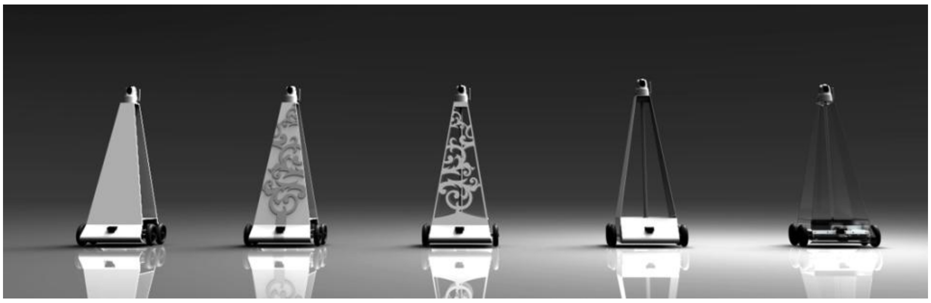

Fig. 7. 3D renders of the design proposals.

During the second roundtable the same participants were asked to discuss a series of design proposals, differentiated by materials and finishes, but all based on the same basic structure. From the observation of these samples the PMMA, a transparent material, was the preferred solution thanks to its ability to confer greater lightness, both from physical and perceptive point of views. In addition, as already happened in the first roundtable, the participants preferred the versions with decoration, which represented a typical Baroque décor. Finally, the decoration was redesigned on the basis of the suggestion from the manager of the castle. She suggested to use the *Palagian Palm*, a distinctive shape which recurs in most of furniture and architectural elements of the castle. To devote much attention to the appearance of the robot might appear unnecessary since this operates in an inaccessible area and, therefore, is not visible from the public. Nevertheless, it assumes a strategic role due to the fact that the project was developed for a real context where it has to be accepted from the various stakeholders. The social acceptance of the project, in fact, is determined also by the visual impact on the stakeholders. The appearance of Virgil, which reminds to the context, does not invoke the stereotype of the robot, avoiding of incurring into worries and prejudices.

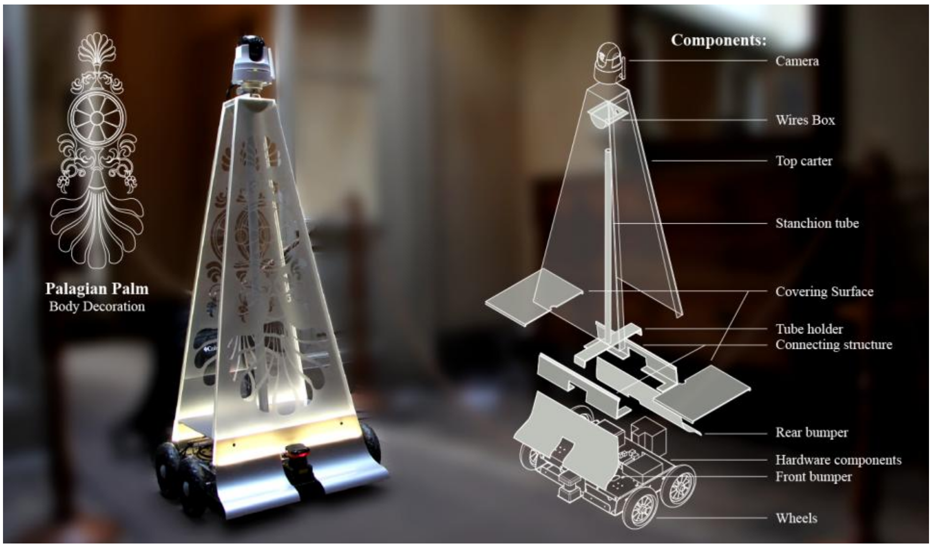

Fig. 8. Virgil, prototype and components.

The iterative approach of the project has also led to a continous refinement of the prototype. The improvements concerned four main aspects: structure, camera, wheels and speed. Regarding the structure, the pyramid shape remained unchanged, while the centroid has been moved in order to make the robot able to climb surfaces with an 8 degree of inclination (the same of ramps for wheelchairs), without slipping or overturning. The camera, instead, has been changed for reducing image distortion and obtaining a higher quality of the chromatic tones. This aspect is crucial for the proper fruition of the heritage since these kind of contexts are characterised by the atmosphere: soft lighting and strong contrasts. Finally, the movement of the robot has been improved. On one hand, by replacing the wheels for obtaining more grip. On the other hand, the engine power has been increased as well as the level of battery autonomy.

4.7 GUI

In parallel with the prototyping of the robot, we developed a preliminary study for the redesign of the graphical user interface (GUI). In this phase, the engineers involved in the project provided a prototype of the GUI with all the functional components of the interface. We analysed the GUI from the functional and ergonomic point of view in order to make it more usable and intuitive for the museum guide, that should be the primary user. For this reason, also this design stage involved the museum guide, who provided continuous feedbacks and suggestions. The redesign of the GUI is still ongoing and it will be also realized taking into account the future developments of the service.

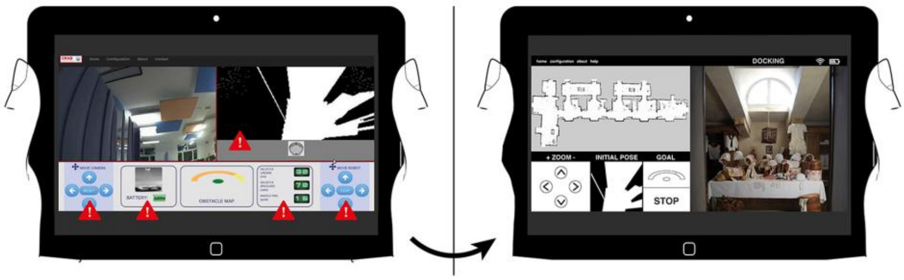

Fig. 9. GUI: first prototype (left) and preliminary study for the redesign (right).

5 Field Tests with Real Visitors

In order to assess the validity of the project it was necessary to test it in the real environment involving real users. For this reason, we organized two experimental sessions at the Racconigi Castle, during which two rounds of guided tours, one in the morning and one in the afternoon, were extended with the introduction of the robotic experience. The visitors involved, invited to attend a guided tour for free, were not informed about the novelty. This choice was based on the willingness to prevent the rise of expectations and preconceptions.

The test consisted in a guided tour during which the visitors were accompanied by a Museum Guide through the normal exhibit tour and then in a room specially arranged for the robotic experience. The set up of this room consisted of armchairs for visitors, a projection system, a sound system and a tablet on which was installed the GUI to control the robot. During the robotic experience, the streaming video of the remote exploration was alternated with some multimedia insights, such as a slideshow of historical pictures, videos and soundtracks, and, in the end, the museum guide showed a slide in which were summarized the purposes of the project and the future developments, in order to give them a brief overview about the project. Finally, after the end of the visiting experience, the participants were asked to complete a questionnaire about their visit, which addressed both general information and a focus about the robotic experience.

The choice to use a questionnaire-based study was led by the need to ask visitors the shortest possible time. In fact, since the testers were normal visitors unaware of the robotic novelty, in most of cases they were already organized to visit other sites after the Racconigi Castle. This means that most of them had no time to spend on interviews. This constrain was highlighted by the museum guide who has a deep knowledge of the visitor's habits. The evaluation of the experience through a questionnaire was supplemented with the report of the user observation, carried out by two members of the design team. They were instructed to observe and write down the main aspects of the visitor's behaviour, like if the visual focus was on the museum guide, on the projected images or rather if they were distracted and appeared bored.

Fig. 10. Field test in Racconigi Castle with a group of visitors.

6 Results

For this testing phase was involved a total of 55 people, a group of 28 in the first day of test and a group of 27 in the second day (divided in morning and afternoon tours). The 62% of the sample was women and the 38% men. They were aged between 8 and 80 years, and around the 40% was more than 60 years old. Just the 25% of them have a degree. They were mainly couples, families and groups of friends. These data show that the sample, even if relatively small, is representative of the people typologies that usually visit the castle.

The experience of visit was evaluated, in general, on the base of four adjectives, namely: entertaining, engaging, unexpected and cultured. The feedbacks gave by the sample were mostly positive. In fact, more than 85% stated that the experience was entertaining and engaging.

Visitors were also asked to specify which of the themes addressed during the visit were most interesting for them. The vast majority, 53%, expressed interest in objects, customs and traditions, whilst a 27% preferred architecture and history of the building and a 25% curiosity about historical characters. It was also asked which of these themes they would like to deepen. The interest for objects, customs and traditions, as well as curiosity about historical characters were both confirmed, each by more than

33% of the sample. In addition, the 18% of the visitors expressed curiosity about the relationship between the Racconigi Castle and other cultural heritage of the territory. The visitors, then, were asked to express their level of satisfaction about four main characteristics of the robotic visiting experience, namely: picture colour quality, stability of the video, movement of the robot and quality of sounds and voices. The participants gave, generally, positive feedbacks, particularly regarding the picture colour quality (more than 75%) and the quality of sounds and voices (89%). However, in some cases there were negative opinions. Concerning the movement of the robot and the stability of the video the 16% of the sample was not satisfied.

Other questions were related to the appearance of the robot. It was asked to the participants if the design of the robot was interesting for them, if it was appropriate for the context and if the use of robotics in this museum context was useful. For all the three questions the answers were similar: more than 70% of the participants gave positive feedbacks. In particular, the use of robotics in the museum context was considered useful or very useful by the 85%. They were also able to leave a comment about why they think the robotics is useful and most of them reaffirmed that it is interesting to have the possibility to explore inaccessible areas of the castle.

Afterwards, the participants were asked to say if, in the future, they would like to visit other areas of the castle, currently inaccessible, and if they would like to drive the robot. Most of participants, 89%, stated that would be interested in exploring other areas of the castle, currently inaccessible. As regards to the possibility of driving the robot the consensus was lower, 64%, while around a 14% stated that is not interested in this possible future development.

Finally, visitors were invited to leave comments about negative or positive aspects about the experience and none of them gave a negative comment, whereas the positive comments largely emphasized the professionalism of the museum guide, the quality of the cultural storytelling and the attention paid to details. Citing the comment of a participant: *"the emotion of the past"*.

In the last part of the questionnaire, the comments left by the participants of the field-test demonstred how the proposed service met its main objectives: show hidden areas of the castle without impact on the cultural experience and enhance the storytelling activity of the museum guide. In fact, most of them considers that the use of robotics in the museum context is usefull, precisely because "*the robot can go where people can not*" and "*allows to overcome logistic and administrative issues*". And, above all, people largely appreciated the cultural storytellyng made by the museum guide who is the only protagonist of all the final feedbacks.

The report of the observation confirmed some of these data from questionnaire. In fact, most of participants have stated that the experience was entertaining and engaging and both the observers reported that the visitors appeared highly involved in the visit. In particular, some people appeared to be amazed by the novelty. For instance, there was a male participant, aged about 60, who was really exited by the experience. This was noticeable by the fact that he was constantly moving on the armchair, leaning forward the torso, as to see better. He was also constantly smiling and often seeking eye contact with his partner. The smile and seek for eye contact were also noticed on the vast majority of the participants, especially those aged over 50. On the contrary, the younger participants, aged between 8 and 13, appeared to be less involved. They were sitting in a very relaxed way and smiling less than adults.

Overall, when the robot was moving and showing the real time images of the inaccessible area, people were mostly focusing on these while when the projection was showing the multimedia contents the visitors were more looking at the museum guide, who in both cases was talking. At the end of the experience almost half of the participants expressed their appreciation for the project and thanked us. Contrariwise, a couple of participants aged around 30, were visibly not pleased during the whole experience, they were almost never smiling, but they spontaneously went to the museum guide to talk about the project and to understand more deeply. From the conversation we found out that one of them was working at the castle and he lost that job there because of the financial issues of the administration. His concern, that influenced also his partner, was related to the adoption of expensive technologies in a context that is currently unable to ensure the necessary care of the heritage and the jobs that depend on this. After the conversation with the museum guide both of them were much more relaxed and friendly, but this example is fundamental to keep in mind the complexity related to the introduction of new technologies, especially in public context.

7 Lesson Learned

Performing the experiment in the wild [31] as if it was an actual museum's service, generates two main positive drawbacks: ecological validity and sample pertinence. As a matter of fact, the context used for the tests was exactly the one for which the robotic service was designed. This allowed to avoid issues related to the ability to reproduce a realistic setup in the laboratory. Furthermore, the sample of participants is realistic as well. It represents the vast majority of the museum's visitors, excluding groups of scholars. This was possible thanks to the casual and various nature of the participants, involved as a usual group of visitors. This peculiarity allowed to: avoid feedbacks influenced by expectations regarding the novelty, and to receive spontaneous comments. Nevertheless, running the experiment in the wild implies a lower level of control and the impossibility to reproduce additional analysis on the same test, since the experience was not recorded. Recorded images of the experiment would have enabled, for instance, a precise analysis of facial expression, from which it is possible to understand the level of engagement and enjoyment of the participants. Unfortunately, it was not possible to record the experience for privacy issues. To do that, it is necessary to inform the participants and ask them to sign an agreement form, but this would have made impossible to carry out the study as an actual service of the museum, influencing their experience. In order to compensate this critical issue, it would be useful to improve the direct observation by developing specific tools, such as observational boards reporting all the aspects that have to be observed with related specificity.

8 Conclusion and Future Work

The first part of the Virgil project, concluded with the field tests with users, gave highly positive feedbacks. The visitors, indeed, perceived the solution as useful and appreciated most of the aspects of the visit. Nevertheless, a large amount of work is still to be done: on one hand, some aspects of current solution need to be improved, such as the stability of the images and the movement of the robot, but also the re-design of the GUI, on the other hand, the experience will be further expanded and made more interactive, in order to involve visitors actively. During the tests, in fact, it became evident the fact that the limits of the current version of the GUI create difficulties to the museum guide. As a matter of fact, to now, some actions can't be performed through the GUI, such as the activation of then multimedia contents, which have to be launched by another computer. In some moments the coordination between the teleoperation of the robot (on the tablet) and the launch of multimedia contents drove the museum guide to make some mistakes in the order of activation. This issue is crucial since our aim was to develop a tool to enhance the storytelling activity of the museum guide but the current solution is adding complexity to his work. For this reason the redesign of the GUI and the implementation of the various actions appear to be fundamental. This should be simplified and made more intuitive in order to be usable both for the museum guide and, in the future, visitors. Another important future development, indeed, is the creation of a more engagin experience allowing visitors to drive directly the robot and interact virtually with the elements of the inaccessible areas. This will take place as cultural game in which the visitors will have to find, select and answer to some questions to get insights about the objects. This idea to connect additional insights to objects was fairly validated by the data of the field-test questionnaire, in which many participants stated to be interested in objects, customs and traditions. Even if the possibility to drive the robot was not interesting for all the participants, most of them stated that would be interested in visiting other inaccessible areas of the castle and almost the half of them would be interested to receive further information about objects, customs and traditions. Furthermore, during the tests we noticed that the setup, with people sitted in front of the museum guide, is not the best solution, since create a distance among them and the visitors can just watch the video passively. So, our aim is also to reduce the distance between the visitors and the museum guide and to create a more active experience.

In conclusion, the Virgil project is based on the willingness to apply a human-centred approach in order to create a valuable and ethical solution for a real context. The methodology applied, then, put in place strategies of participation and co-design, involving multiple stakeholders, to develop a solution born from shared decisions. In fact, the process of continuous debate that we carried out is meant, not only to create an acceptable solution, rather to enable the occurrence of the mutual shaping of robotics and society [3].

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